ionisation, we can apply Nernst's theorem of the "reaction-isobar" to calculate the amount of ionisation under any given thermal stimulus. The method is based upon a remark of Nernst in his book, "Der Neue Wärmesatz . . ." (p. 154), that the electron may be regarded as a monatomic gas of molecular weight $\frac{1}{1836}$, and that its chemical constant can be calculated according to the Tetrode-Sackur relation

$$C = \log\frac{(2\pi m)^{\frac{3}{2}}k^{\frac{3}{2}}}{h^3}.$$

It has recently been applied by Eggert (*Ver. d. D. Phys. Gesell.,* December 15, 1919) for the calculation of the degree of ionic dissociation in the interior of a star, as supposed by Eddington in his theory of stellar structures. But Eggert calculates U in a rather artificial manner for iron from assumed atomic dimensions and structures of the iron atom.

We can, however, calculate U directly from the value of the ionisation potential as experimentally determined by Franck and Hertz, MacLennan, and others, or from the quantum relation

$$V = \frac{h\nu}{e},\ \nu = (1\cdot5, s).$$

Using the value of U determined in this way for calcium, barium, strontium, hydrogen, and helium, the following remarkable results appear:

(1) About 30–40 per cent. of the Ca atoms are ionised just over the photosphere; in the chromosphere, when the pressure falls to 10^{-4} atms., almost all the Ca atoms are ionised. The same conclusion holds to a varying degree for Ba and Sr.

(2) Hydrogen and helium are not ionised anywhere in the solar atmosphere. (This is due to their high ionisation potential. V is 13·6 for H and 20·5 for He, while for Ca, Sr, and Ba the figures are 6·12, 5·7, and 5·12.) Helium can become ionised only in stars of which the temperature exceeds 16,000 K.

(3) Pressure has a great influence on ionisation, a reduction in pressure causing great enhancement of ionisation.

It therefore appears that the ionisation in the upper layers of the solar atmosphere, as revealed by the enhanced lines of Ca, Sr, and Ba, and probably also of Fe, Ti, and Sc, is due to reduced pressure and the low ionisation potentials of these elements, and not to an increased temperature.

The full theory has been worked out in a paper communicated to the *Phil. Mag.* M. N. SAHA.

University College of Science, Calcutta,
March 8.

Gravitational Deflection of High-speed Particles.

IN a letter published in NATURE of March 11 Prof. Eddington has shown that the statement made by me in an earlier letter to the effect that Einstein's law of gravitation seems to lead to a zero deflection for a material particle moving with the velocity of light is not in accord with the exact equation of the orbit contained in his report to the Physical Society, and suggests that my approximations were not sufficiently close to warrant my conclusion. The line element from which Prof. Eddington derives the equation of the orbit is expressed in co-ordinates which make the velocity of light different in different directions at any one point, whereas the one used by me requires that the velocity of light should be a function of position only, and not of direction. In terms of my co-ordinates the equation of the orbit of a particle moving with the velocity of light is

$$u = 2\frac{m}{R^2} + \frac{1}{R}\left(1 - 2\frac{m}{R}\right)\cos\theta,$$

which leads to the same deflection $4\frac{m}{R}$ for a material particle moving with the velocity of light as for a light-ray. Hence it is clear that my previous conclusion was based on an insufficiently close approximation, and therefore erroneous.

I am glad to see that Prof. Eddington has verified the other principal conclusion of my letter.

LEIGH PAGE.

Sloane Laboratory, Yale University, New
Haven, Connecticut, March 29.

Science and the New Army.

IT requires some courage to offer any opposition to the chorus of approval which has greeted the suggestion that a proportion of officers endowed with the scientific spirit should be included in the General Staff; but I venture to think that it is by no means so easy to give effect to this proposal as some correspondents in NATURE seem to suppose. No doubt it would be delightful if we could have Staff officers who knew all about everything, but in actual practice the man who does useful work in the world is a specialist in one particular subject or in one particular branch of work.

A good regimental officer requires a particular kind of training and possesses a certain set of qualifications. Similarly, a good Staff officer requires a different training and possesses a different set of qualifications. A man of science, again, is different from either of the other two.

The proportion of officers in the Army as a whole who possess any scientific training is comparatively small. There are a certain number of specialists whose ordinary duties are of a technical nature, and there are a few officers who take up some branch of science as a hobby, but the work of the average officer is not such as to bring him into touch with scientific thought and scientific methods. Men are to be found who are good Staff or regimental officers and also scientific workers, but they are exceptions, and it seems to me that a system which demands a regular supply of exceptional men is not one which is likely to work in practice.

There is also a further difficulty. Granting, for the sake of argument, that there are sufficient officers in the Army who possess both the scientific spirit and the qualities necessary for potential Staff officers, it is still necessary to devise a method of selecting them from their more ordinary fellows. Two methods are in common use, namely, examination and nomination.

An examination is a good method of testing that form of knowledge which is acquired by study, but it will be generally agreed that it is not a good method for detecting the scientific spirit. The difficulty in the case of nomination is that the candidates must be selected by ordinary regimental officers who can alone be acquainted with the qualifications of the individual candidates. The average regimental officer, however, is not himself a man of science, and I cannot see that he can ever become a judge of another officer's scientific attainments.

Without arguing, therefore, against the desirability of a General Staff containing an appreciable proportion of scientific officers, I suggest that the ideal is unattainable except in so far as specialists are attached to the Staff for their own particular work, and I think the object in view must be attained by some other means. It might be done by raising the general standard of education in scientific matters throughout the country but this is a very large question, and not a very easy one.

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Probably the best hope of an immediate improvement in the relations between science and the Army lies in the direction suggested by Prof. Filon in his letter in Nature of April 1, in which he says:—"I would suggest . . . that what is most urgently needed for General Staff officers is a course of scientific classification and organisation, where they would be taught the real meaning of scientific qualifications and the names of living authorities in various subjects."

The position of the Signal Service is a case in point. I think I am correct in saying that a few years before the war there was scarcely an officer outside the Signal Service itself who knew what that Service was. It was generally recognised among the officers of the Signal Service that one of their chief duties would be to advise and instruct the staff in the possibilities and limitations of the Service, and that this duty would not be less important than the supervision of the technical duties of the Service itself. This principle was applied both in manœuvres and during the war, and I think that the correctness of the views held was fully borne out by experience. The ordinary Staff officer eventually learnt that battles could not be fought without signals, and that it was necessary to take the senior signal officer into his confidence if the best results were to be obtained.

I suggest that men of science in general might well follow this example. They should realise that the Staff officer is a specialist in his own particular business and that he cannot know everything, and they should themselves advise him how science can be used and what are its limitations.

Technical and scientific societies might themselves select small committees which would be prepared to advise the War Office or other Government Departments on technical matters. The committees might also be prepared to nominate gentlemen who could visit the Staff College and other military centres and give lectures on their own special subjects. The lectures would not deal with technical matters to any great extent, but their purpose would be to show what had been done by the particular science or industry during the war, and to indicate in what directions assistance might be expected in future.

One further suggestion I should like to make. Certain sums are allotted from time to time in connection with experiments on the design of military equipment, and these funds are devoted to work which is carried out almost entirely by military officers acting under the instructions of War Office Committees. The funds now allotted are small, but I suggest that additional sums might be given for research work on military subjects which might be allotted by the War Office Committees to technical or scientific institutions outside the Army. Periodical discussions between the War Office Committees and the technical institutions with regard to these researches would tend to keep the War Office Staff in touch with leading scientific and technical workers outside, and it would permit of those personal exchanges of opinion which are worth all the official letters which were ever written.

K. E. Edgeworth.

Crowborough, April 11.

The Universities and the Army.

The proposals contained in the leading article in Nature of April 8, that the raw material for the commissioned ranks should be university graduates rather than public-school boys, may be ideal, but it would have been more practicable in 1914 than it is at the present day. Under the existing pressure on the universities there is rather a risk of the Army candidate being squeezed out; there is not accommodation for all candidates for commissions to enter freely. For the moment we shall have to be content with a measure by which selected officers can be accepted at universities for specialised training not readily available elsewhere. Thus the Services can obtain that contact with living science which is so essential for them, and has been so often lacking in the past. This will require supplementing by courses within the fighting Services if proper preparation is to be made for the scientific aspects of the next war. At least at the various Staff colleges trained scientific workers must lecture, while selected officers should be sent to work in university laboratories. The present state of friendly co-operation must not be allowed to disappear.

The practice of farming out research problems to scientific institutions may have favourable results if pursued in a long-sighted manner and supported by adequate grants (and, where necessary, by field or marine trials). Given close co-operation, it should lead to many problems of defence and offence being foreseen and solved in advance. The man of science should have his chance of pointing out to those who must listen (and who have the power of decisive action) what key industries are vital to the country's safety, and cannot be allowed to pass entirely to other lands. The necessary mobilisation of science at the next emergency should be quicker and more practical, and the man of science should have a better sense of the nature of the problems that are likely to be sprung upon him to solve.

One word by way of conclusion. The fighting Services are not the only national Services that would gain by a wide infusion of scientific knowledge and method.

F. J. M. Stratton.

Gonville and Caius College, Cambridge.

Early Hawthorn Blossom.

The first sound of the cuckoo and the first flowers of the hawthorn have come this year about the same time, which is surely a remarkable occurrence.

It is not unusual for hawthorn blossom to appear well after the beginning of May, and it has been suggested that the discontinuance of May Day festivities was due in part to the change in the calendar introduced into this country in 1752. The change made May Day eleven days earlier by the sun, and so reduced the chance of obtaining whitethorn blossom, which was the proper ornament for the top of the maypole and for the crown of the May Queen.

Gilbert White's "Naturalist's Calendar" gives April 20 as the earliest date for the unfolding of the hawthorn blossom, but the Rev. C. A. Johns in his book, "The Forest Trees of Britain," states that hawthorn blossom was gathered in Cornwall on April 18, 1846. This year it was seen on April 16 at Northwood, Middlesex.

Jenny Rose.

The Doctor of Philosophy in England.

Referring to the article in Nature of April 15 on this subject, I may perhaps recall to the recollection of the writer that in the University of Aberdeen the degree which is primarily that of Master of Arts confers specifically *Magister Artium et Doctor Philosophiae.*

Henry O. Forbes.

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